RCRA PERMIT

FOR THE

IDAHO NATIONAL LABORATORY

Volume 14
INTEC Liquid Waste Management System

Appendix VIII

EDF-2470, Analysis of Hydrostatic Forces
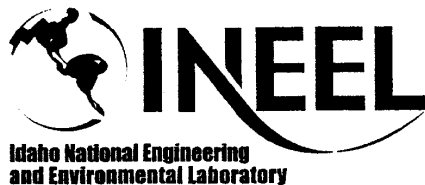on INTEC Liquid Waste Tanks
During a 100-Year Flood

Document ID: EDF-2470
Revision ID: 0
Effective Date: 09/12/02

Engineering Design File

Analysis of Hydrostatic Forces on INTEC Liquid Waste Tanks During a 100-Year Flood

Prepared for:
U.S. Department of Energy
Idaho Operations Office
Idaho Falls, Idaho

INEEL

Idaho National Engineering
and Environmental Laboratory

Form 412.14
07/24/2001
Rev. 03
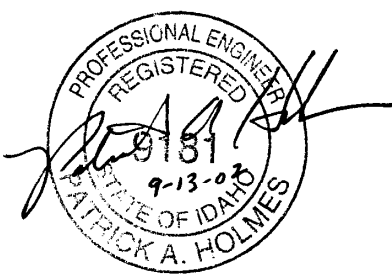
431.02	**ENGINEERING DESIGN FILE**	EDF- _____2470
02/26/2002		Rev. No. _____0
Rev. 10		Page 1 of 14

1.	Title: Analysis of Hydrostatic Forces on INTEC Liquid Waste Tanks During a 100-Year Flood	
2.	Project File No.:	
3.	Index Codes:	
	Building/Type PEWE, LET&D SSC ID _____ Site Area INTEC _____	

4. Summary:

The purpose of this engineering analysis is to provide data regarding the hydrostatic, hydrodynamic, and structural effects of a 100-year peak flood. This analysis is performed to ensure compliance with requirements stemming from application for a RCRA permit for mixed hazardous waste treatment in the Process Equipment Waste Evaporator (PEWE) and Liquid Effluent Treatment and Disposal (LET&D) facilities. RCRA regulations require an engineering analysis to determine the various hydrodynamic and hydrostatic forces expected to result at the site as a consequence of a 100-year flood, and structural or other engineering studies showing the design of operational units and flood protection devices at the facility and how these will prevent washout of hazardous waste.

Previous analyses suggest that the PEWE and LET&D facilities may be exposed to floodwater infiltration. The scope of the present analysis is to determine the hydrostatic and hydrodynamic forces of floodwater acting on the tanks and ancillary piping in the PEWE and LET&D systems, and to determine if these forces will damage the tanks and piping and allow hazardous waste to escape.

Data on tank capacity, dimensions, supports and anchorage was presented for each liquid waste tank in the PEWE and LET&D systems that may be exposed to floodwater forces. These forces include buoyancy and hydrostatic pressure. The buoyancy force acting on the tank may lead to flotation, and external fluid pressure may lead to collapse of the tank wall. Since the buoyancy force on piping is negligible in comparison to those forces on large, empty tanks, it is only necessary to ensure that the tanks are adequately anchored to prevent uplift. It is also necessary to show that the tanks have enough strength to resist collapse of the tank walls.

The results of the analysis showed that the tanks are able to withstand hydrostatic forces resulting from the postulated 100-year flood. These tanks are located in cells that are accessible by an access corridor and a series of doorways that are normally closed. Although water infiltration into the cells is possible by seepage through the edge of doorways, all tanks in the cells are adequately anchored to prevent uplift and have enough strength to resist collapse of the tank walls. Therefore the tanks and piping will not be damaged as a result of floodwater infiltration.

RCRA tanks that are located in concrete vaults are not exposed to water infiltration because the access hatches and pipe penetrations are watertight. The access hatches are always closed except when performing maintenance in the vault, and all pipe penetrations are grouted and sealed to be watertight. Water transfers from the sumps are continually monitored, and if access hatches or pipe penetrations are found to be leaking, sealant or grout is reapplied in order to maintain a watertight vault. Therefore washout of hazardous waste from these tanks will be prevented.

5. Review (R) and Approval (A) and Acceptance (Ac) Signatures:

	R/A	Name/Organization	Signature	Date
Author		P. E. Murray/5225	*P. E. Murray*	9/5/02
Checker	R	N. B. Smith/5225	*N.B.Smith*	9/5/02
Supervisor	A	S. R. Jensen/5225	*S.R. Jensen*	9/12/02
Project Engineer	Ac	P. A. Holmes/5225	*P.A.Holmes*	9/13/02
Requestor	Ac	N. C. Hutten/7310	*N.C. Hutten*	9/13/02
Doc. Control				

6.	Distribution: (Name and Mail Stop)	P. E. Murray, MS 5106

431.02   **ENGINEERING DESIGN FILE**   EDF-_____2470
02/26/2002   Rev. No. _____0
Rev. 10   Page 2 of 14

7. Does document contain sensitive unclassified information? ☐ Yes ☒ No	
If Yes, what category:	
8. Can document be externally distributed? ☒ Yes ☐ No	
9. Uniform File Code: 0286 Disposition Authority: A17-30-c-1	
Record Retention Period: Until Dismantlement or disposal of equipment, or when superceded or obsolete.	
10. For QA Records Classification Only: ☒ Lifetime ☐ Nonpermanent ☐ Permanent	
Item and activity to which the QA Record apply:	
11. NRC related? ☐ Yes ☒ No	
12. Registered Professional Engineer's Stamp	

431.02	**ENGINEERING DESIGN FILE**	EDF- _____ 2470
02/26/2002		Rev. No. _____ 0
Rev. 10		Page 3 of 14

Purpose

The purpose of this engineering analysis is to provide data needed in support of a Volume 14 RCRA permit application to comply with Idaho DEQ requirements for operation of the PEWE and LET&D systems. This analysis is performed to ensure compliance with RCRA regulations that require an engineering analysis to determine the various hydrodynamic and hydrostatic forces expected to result at the site as a consequence of a 100-year flood, and structural or other engineering studies showing the design of operational units and flood protection devices at the facility and how these will prevent washout. In the RCRA regulations, washout is defined as the movement of hazardous waste from the active portion of a facility as a result of flooding.

Scope

A structural evaluation of tanks in the PEWE and LET&D facilities is needed to demonstrate that the tanks and piping will not be damaged as a result of hydrodynamic and hydrostatic forces, which may occur as a result of water infiltration during a 100-year flood. The tanks are located in building CPP-601, CPP-604, CPP-605, CPP-641, CPP-649 and CPP-1618. A previous structural analysis [3] showed that these buildings are exposed to floodwater infiltration through doorways and other openings that are below the floodwater level associated with a 100-year flood coincident with a Mackay Dam Failure [1]. The issue is complicated because there are many different tanks and piping systems involved.

This task includes an evaluation of the PEWE and LET&D buildings to determine if the tanks and attached piping are exposed to flooding. If the tanks are exposed, a structural evaluation is performed to determine if the tanks are adequately anchored to prevent uplift due to buoyancy, and to determine if the tanks have enough strength to resist collapse of the tank walls due to external pressure.

This Engineering Design File (EDF) includes a description of all the affected structures, tank and piping systems, including details on the tank anchorage. The tanks included in this evaluation are those specified in Section D-2c of the RCRA Part B Permit Application, Volume 14. This EDF also includes calculations to determine the hydrostatic force of floodwater tending to cause flotation of the tanks and collapse the tank walls, and calculations to determine restraining forces at the tank supports.

Safety and Performance Categories

Safety categories are used for systems, structures, and components (SSC) to establish a graded approach to design and analysis based on the safety function performed by the SSC. Similarly, performance categories are used for an SSC exposed to natural phenomena hazards to establish a graded approach to design and analysis based on the importance of the SSC. However, the safety category and performance category are not used in this analysis since the design basis flood event and scope of the analysis are governed by RCRA regulations.

Background on 100-Year Flood

Koslow and Van Haaften [1] examined the consequences of a failure of Mackay Dam and performed a hydraulic analysis to determine the extent of the flood plain for several scenarios. Their analysis included a 100-year flood and simultaneous piping failure at Mackay Dam, which leads to a breach of the dam, overtopping of the INEEL diversion dam, and flooding of the INEEL site. This scenario results in a peak flow released from the dam that was calculated to be 57,740 ft^3/s. This flow between Mackay Dam and the INEEL is attenuated by storage, agricultural diversion, and channel infiltration. The calculated flow at the INEEL diversion dam is 28,500 ft^3/s. Since the diversion dam is unable to retain the high flow, most of the floodwater is assumed to flow onto the site.

The peak flow estimated by Koslow and Van Haaften [1] was used in a flow routing analysis to determine the extent of the flood plain at the INEEL site. A hydraulic analysis of open channel flow was used to compute the peak flow and water elevation at each cross-section of the Big Lost River channel. All vertical elevations are in reference to the National Geodetic Vertical Datum of 1929 (NGVD29). Of particular interest in this study are the PEWE and LET&D buildings located at the INTEC facility. The leading edge of the flood wave is estimated to arrive at INTEC approximately 17.1 hours after breach of the dam. The peak flow is attenuated to 24,870

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No._____0
Rev. 10		Page 4 of 14

ft^3/s, and the peak water velocity is estimated to be 2.2 ft/s. Since the area surrounding INTEC is very flat, floodwater will spread easily and so the flood plain is wide and shallow. The elevation of the streambed in the vicinity of INTEC is 4911 ft and the calculated water elevation is 4916 ft. Since the minimum ground elevation at the PEWE and LET&D buildings is approximately 4912 ft, the depth of floodwater may reach 4 ft at some locations.

Koslow and Van Haaften [1] also performed an analysis to examine the potential for overland flooding due to localized heavy rain and snowmelt. It was found that localized flooding due to a 25-year peak rainfall and simultaneous snowmelt lead to a peak flow estimated to be 32 ft^3/s. Although this runoff can be accommodated by the drainage basin at INTEC and flood control devices such as culverts, dikes, and ditches, floodwater may collect in low-elevation areas at the PEWE and LET&D buildings.

Description of Structures

The following buildings comprise the PEWE and LET&D facilities:

CPP-604　　　Process Equipment Waste Evaporator (PEWE) Building
CPP-605　　　Atmospheric Protection System Building (adjoining PEWE)
CPP-708　　　Main Stack for PEWE and LET&D Systems
CPP-1618　　Liquid Effluent Treatment and Disposal (LET&D) Building
CPP-649　　　Off-gas Equipment and HEPA Filter Building
CPP-601　　　Process Building
CPP-641　　　Waste Hold-up Tank Building

The first level finished floor elevations, as shown on the as-built drawings, are listed in Table 1. Elevations are currently measured in reference to the National Geodetic Vertical Datum of 1929 (NGVD29). However, the buildings were constructed when the datum was not NGVD29. Recent elevation measurements in reference to NGVD29, which are approximately 1 ft. less than those shown on the as-built drawings, are listed in Table 1.

Table 1. Building elevation in feet above sea level.

Building	First level floor elevation (shown on as-built drawing)	First level floor elevation – (in reference to NGVD29)	INEEL Drawing Number
CPP-604	4913.0	4912.0	103223
CPP-605	4913.0	4912.0	128821
CPP-1618	4917.0	4916.1	347771
CPP-649	4912.8	4911.9	128837; 128840
CPP-601	4917.0	4916.0	103062
CPP-641	4916.0	4915.0	111809

The floodwater elevation for the postulated 100-year flood coincident with a Mackay Dam failure is 4916 ft in reference to NGVD29 (Koslow and Van Haaften, [1]). The wave height of shallow water waves generated by a 60 mph wind with a water depth equal to 4 ft is approximately 2 ft from crest to trough (Fig. 10-16 in Brater and King [2]). In many cases, exterior openings such as doorways and loading docks lead to the active portion of the building containing waste, and floodwater may enter the building if the first level floor elevation is less than 4917 ft (still water level + ½ wave height). Therefore, all the buildings listed in Table 1 are exposed to potential floodwater infiltration.

The buildings are constructed of reinforced concrete. Previous analyses of floodwater forces on CPP-604 [3], CPP-1618 [3], and CPP-659 [4] showed that the foundation walls are strong enough to withstand hydrostatic and hydrodynamic forces. Therefore, the main concern is floodwater infiltration and the resulting hydrostatic force on tanks and ancillary piping, and whether the tanks and pipes will be damaged and allow hazardous waste to escape. It is only necessary to consider the exposed structures and show that the tanks and piping can withstand the hydrostatic pressure. In particular, it is necessary to check that external pressure on tank and pipes does not collapse the walls, and the buoyancy force does not cause the anchor bolts and pipe supports to fail.

431.02	**ENGINEERING DESIGN FILE**	EDF- 2470
02/26/2002		Rev. No. 0
Rev. 10		Page 5 of 14

Assumptions

1. In case the floodwater elevation is higher than the elevation of doorways or other openings, it is assumed that the building is exposed to floodwater infiltration [a].

2. The only pathway for water infiltration into a tank vault is at access hatches and pipe penetrations, which are assumed to be sealed and watertight [b].

3. The concrete foundation of the building is assumed to withstand hydrostatic and hydrodynamic forces, which is based on a previous analysis of floodwater forces on the PEWE and LET&D buildings [3].

4. Buoyancy force and external pressure on piping and pipe supports are negligible in comparison to those forces on large, empty tanks.

5. The liquid waste tanks are assumed to be empty and completely immersed in water since this leads to the maximum buoyancy force and pressure on the tank wall.

6. The tanks and piping are completely sealed and do not leak since they are regularly inspected.

7. Reduction of tank wall thickness due to corrosion is neglected since the stainless steel used to fabricate the tanks is very resistant to corrosion by nitric acid.

8. The anchor bolt (or rod) is assumed to be stainless steel type 304, and the strength of the bolt (or rod) is assumed to govern the capacity of an anchor [c].

9. In the event of a flood, it is assumed that the evaporation/separation/condensation operations in CPP-604 will be shut down and no steam or high temperature condensate will be present in the tanks.

---

[a] Sumps and steam jets in the cells and vaults can remove water infiltrating the building. Cells are accessible by doorways that are not watertight but are normally closed. Plugging the edges of doorways can significantly reduce the infiltration rate. In this analysis, no calculations are made of the infiltration rate through doorways or other openings.

[b] The access hatches at the CPP-604 storage tank vault (Drawings 103553), the CPP-604 feed tank vault (Drawing 162319), the CPP-641 vault (Drawing 111809) and the CPP-601 vault (Drawing 103064) are removable, tapered concrete plugs fitting into the tank vault concrete roof slab and designed to contain a watertight seal on all sides.

[c] High-strength stainless steel is commonly used for bolting material, and so the strength of the bolt is often larger than the strength assumed in the analysis.

Discussion

The tanks contained in storage vaults are not exposed to flooding since the access hatches and pipe penetrations are watertight. These tanks include the CPP-604 waste storage tanks (WM-100, WM-101, WM-102, WL-101, WL-102 and WL-150), the CPP-604 feed tanks (WL-132 and WL-133), the CPP-641 storage tanks (WL-103, WL-104 and WL-105), and the CPP-601 storage tanks (WH-100, WH-101, WG-100 and WG-101). The hatches are always closed except when performing maintenance in the vault, and all pipe penetrations are grouted and sealed to be watertight. Any water infiltration due to seepage at pipe penetrations and hatches is minor and readily removed by sumps and steam jets, as shown in a previous analysis of water seepage into CPP-604 [3]. Furthermore, it is necessary that the valve (PLV-YDB-28) on the vent line protruding from the CPP-641 tank vault (Drawing 111807) be closed during a flood.

The small tanks in the PWL collection system (WL-135, WL-136, WL-137, WL-138, WL-139, WL-142, and WL-144) have a capacity not exceeding 25 gallons and are adequately supported by the attached piping. Tank NCR-171 is located at CPP-659, which is not exposed to water infiltration as shown previously [4]. All the tanks in CPP-1618, except the bottoms tank (WLL-195), are above the floodwater elevation.

The tanks contained in the PEWE cells and the LET&D bottoms tank pit are exposed to flooding since they are accessible by doorways and other openings that are not watertight. Although doorways are normally closed, water infiltration into the cells is possible by seepage through the edge of doorways. Similarly, water infiltration into the bottoms tank pit is possible by seepage through the edge of the cover plate. Therefore it is necessary to evaluate these tanks in order to ensure that the anchorage is strong enough to prevent uplift and the tank wall is strong enough to resist collapse. The data used in the structural evaluation of the tanks are given in Tables 2-6.

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No. _____0
Rev. 10		Page 6 of 14

List of Tanks

The capacity of each tank and the building in which it is located are given in Table 2 for all the tanks in the PEWE and LET&D systems listed in the RCRA Part B Permit Application, Volume 14, Section D-2c.

Table 2. Capacity of waste storage tanks.

Tank Identifier	Building	Capacity (gal.)
WM-100	CPP-604	18,400
WM-101	CPP-604	18,400
WM-102	CPP-604	18,400
WL-101	CPP-604	18,400
WL-102	CPP-604	18,400
WL-133	CPP-604	19,000
WL-132	CPP-604	4,700
WL-106	CPP-604	5,000
WL-107	CPP-604	5,000
WL-163	CPP-604	5,000
WL-103	CPP-641	5,000
WL-104	CPP-641	5,000
WL-105	CPP-641	5,000
WH-100	CPP-601	4,500
WH-101	CPP-601	4,500
WG-100	CPP-601	4,500
WG-101	CPP-601	4,500
WL-111	CPP-604	1,500
WL-129	CPP-604	1,000
WL-161	CPP-604	1,000
WL-300	CPP-604	250
WL-307	CPP-604	250
WL-301	CPP-604	180
WL-308	CPP-604	180
WL-131	CPP-604	66
WL-134	CPP-604	500
WL-108	CPP-604	70
WL-109	CPP-604	270
WL-135	CPP-649	10
WL-136	CPP-649	10
WL-137	CPP-649	25
WL-138	CPP-605	25
WL-139	CPP-605	10
WL-142	CPP-604	10
WL-144	CPP-604	25
WL-150	CPP-604	50
WLK-197	CPP-1618	270
WLL-170	CPP-1618	460
WLK-171	CPP-1618	460
WLL-195	CPP-1618	270
NCR-171	CPP-659	22,500

431.02
02/26/2002
Rev. 10

ENGINEERING DESIGN FILE

EDF-_____2470
Rev. No._____0
Page 7 of 14

Depth of Tanks

The hydrostatic force will affect the large, empty tanks at maximum depth since the maximum hydrostatic pressure occurs at the lowest elevation. The depth of the tank below the floodwater elevation is given in Table 3 for the tanks in the PEWE and LET&D systems that are exposed to floodwater infiltration. The depth is measured to the floor of the PEWE evaporator and condenser cells or the floor of the LET&D bottoms tank pit.

Table 3. Depth of waste storage tanks.

Tank Identifier	Depth of tank below floodwater elevation (ft)	INEEL Drawing Number
WL-106	27	056692
WL-107	27	056692
WL-163	27	056692
WL-111	27	056692
WL-129	27	056692
WL-161	27	056692
WL-300	27	056692
WL-307	27	056692
WL-301	27	056692
WL-308	27	056692
WL-131	27	056692
WL-134	27	056692
WL-108	27	056692
WL-109	27	056692
WLL-195	5.7	347796

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No._____0
Rev. 10		Page 8 of 14

Weight of Tanks

The hydrostatic force of floodwater in the building will affect the large, empty tanks immersed in water since the buoyancy force is proportional to the volume of displaced water. The weight of the empty tank and the weight of contained water are given in Table 4 for the tanks in the PEWE and LET&D systems that are exposed to floodwater infiltration. The weight of contained water is calculated using the capacity given in Table 2.

Table 4. Weight of waste storage tanks.

Tank Identifier	Weight of empty tank (lb)	Weight of contained water (lb)	INEEL Drawing Number
WL-106	8300	41,700	098921
WL-107	8300	41,700	098921
WL-163	8400 [1]	41,700	056638
WL-111	4600 [1]	12,500	097880
WL-129	5320 [2]	8340	055920
WL-161	5320	8340	097722
WL-300	1150 [1]	2090	057231
WL-307	1150 [1]	2090	057231
WL-301	830 [1]	1500	055895
WL-308	830 [1]	1500	055895
WL-131	370 [1]	550	155074
WL-134	1100	4170	83-1529 [3]
WL-108	480 [1]	580	E-51-687-B [4]
WL-109	600 [1]	2250	098920
WLL-195	1500	2200	097672

[1] Approximate weight based on dimensions of shell and heads given in drawings; weight of piping and flanges is neglected.

[2] Weight of WL-129 assumed to be the same as weight of WL-161, since both tanks are similar flash columns.

[3] Vendor drawing from Mabe Industries.

[4] Vendor drawing from W. K. Mitchell & Co.

431.02	**ENGINEERING DESIGN FILE**	EDF- _____ 2470
02/26/2002		Rev. No. _____ 0
Rev. 10		Page 9 of 14

Diameter and Wall Thickness of Tanks

The hydrostatic force will affect the large, empty tanks at low elevation since the hoop stress in the tank wall is proportional to the tank diameter and the difference in external and internal pressure, and inversely proportional to the wall thickness. The tank diameter and the wall thickness are given in Table 5 for the tanks in the PEWE and LET&D systems that are exposed to floodwater infiltration.

Table 5. Diameter and wall thickness of waste storage tanks.

Tank Identifier	Tank Diameter (ft)	Wall Thickness (in.)	INEEL Drawing Number
WL-106	8	0.5	098921
WL-107	8	0.5	098921
WL-163	8	0.5	056638
WL-111	4.7 [1]	0.375 [2]	097880
WL-129	3	0.375	055920
WL-161	3	0.375	097722
WL-300	2 [3]	0.375	057231
WL-307	2 [3]	0.375	057231
WL-301	2.2	0.375	055895
WL-308	2.2	0.375	055895
WL-131	2	0.375	155074
WL-134	3.5	0.1875	83-1529 [4]
WL-108	2.5	0.375	E-51-687-B [5]
WL-109	3	0.25	098920
WLL-195	3	0.5	097673

[1] Equivalent diameter of rectangular tank cross-section.

[2] Wall thickness obtained from D. J. Henrikson, "Evaluation of PEW Tank VES-WL-111," CSS-94-003 (March 1994).

[3] Tank diameter is not given on the drawings, but is estimated to be 24 inches.

[4] Vendor drawing from Mabe Industries.

[5] Vendor drawing from W. K. Mitchell & Co.

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No._____0
Rev. 10		Page 10 of 14

Anchoring of Tanks

The tanks that are exposed to potential floodwater infiltration are anchored to prevent flotation. Descriptions of the tank support and anchorage are given in Table 6 for the tanks in the PEWE and LET&D systems that are exposed to floodwater infiltration. The anchoring details are given as the total number and size of bolts. It was necessary to determine the exact anchoring details for each tank in which these details are not given on the drawings but are present nonetheless.

Table 6.Anchoring of waste storage tanks.

Tank Identifier	Tank orientation and support	Anchoring details	INEEL Drawing Number
WL-106	Vertical, steel legs	4 – ¾ in. bolts [1]	098921
WL-107	Vertical, steel legs	4 – ¾ in. bolts [1]	098921
WL-163	Vertical, steel legs	4 – ¾ in. bolts [1]	056638
WL-111	Horizontal, steel legs	4 – 1 in. holes [2]	097880
WL-129	Vertical, steel brackets	2 – ¾ in. bolts	155072
WL-161	Vertical, steel brackets	4 – ¾ in. bolts	056079
WL-300	Vertical, steel brackets	2 – ¾ in. bolts	056079
WL-307	Vertical, steel brackets	2 – ¾ in. bolts	155072
WL-301	Vertical, steel brackets	4 – ¾ in. bolts	056079
WL-308	Vertical, steel brackets	4 – ¾ in. bolts	155072
WL-131	Horizontal, steel legs	4 – ½ in. bolts	155074
WL-134	Vertical, steel legs	4 – 7/8 in. bolts	83-1529 [3]
WL-108	Vertical, steel brackets	2 – 7/8 in. holes [2]	E-51-687-B [4]
WL-109	Vertical, steel brackets	2 – 7/8 in. holes [2]	098920
WLL-195	Horizontal, steel saddles	4 – 7/8 in. bolts	347796

[1] Anchoring details are not shown on the drawings, but photographs of the condensate cell show that the steel angles are welded to steel plates bolted to the concrete floor (see Attachment A). Drawing No. 158768 shows a typical anchorage, but the size of the bolts is not shown. Four ¾ in. diameter bolts are assumed, which is based on the weld size specified on Drawing No. 158768.

[2] Anchoring details are not shown on the drawings, which show instead the size of holes in each support. It is standard engineering practice to use anchor bolts in an oversized hole. It is assumed that a ¾ in. bolt is used in a 1 in. hole, and a 5/8 in. bolt is used in a 7/8 in. hole.

[3] Vendor drawing from Mabe Industries.

[4] Vendor drawing from W. K. Mitchell & Co.

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No._____0
Rev. 10		Page 11 of 14

Hydrostatic Forces on Tanks

Assuming the tanks are empty and immersed in water, the net uplift force on the tanks due to buoyancy is

$$P = W_{water} - W_{tan k}$$

W_{water}　　　　　　Weight of displaced water from Table 4

$W_{tan k}$　　　　　　Weight of empty tank from Table 4

The anchor bolts must have enough strength to withstand the uplift force tending to cause flotation of the tanks. The calculations of uplift force are given in Table 7 for the tanks in the PEWE and LET&D systems.

The tank walls must also have enough strength to withstand the hydrostatic forces tending to cause collapse of the tank walls. Assuming the tanks are empty and immersed in water, external pressure acts on the tank walls.

The hydrostatic pressure corresponding to the hydraulic head is

$$p = \gamma_{water} \times H = 62.4\,lb/ft^3 \times H$$

H　　　　　　Hydraulic head from Table 3

The calculations of hydrostatic pressure are given in Table 7 for the tanks in the PEWE and LET&D systems.

The tanks listed in Table 7 are fabricated according to ASME Section VIII Code with design pressures that include either full vacuum or 0.5 psia (15 in. H_2O) in addition to internal pressure. Note that the hydrostatic pressure given in Table 7 is less than the external pressure resulting from either full vacuum or 0.5 psia.

The restraining force of anchor bolts is calculated using the resistance factor and nominal strength formula given in IBC-2000 Sections 1913.4 and 1913.5 [5]. The minimum yield strength of stainless steel bolts is 30,000 psi (ASTM 193 Grade B8 Class 1, type 304).

The strength of the various sizes and types of bolts used to anchor the tanks is

½ in. bolt:　　　　　　$\phi \times f_y \times A = 0.90 \times 30,000\,psi \times 0.142\,in.^2 = 3,830\,lb$

5/8 in. bolt:　　　　　　$\phi \times f_y \times A = 0.90 \times 30,000\,psi \times 0.226\,in.^2 = 6,100\,lb$

¾ in. bolt:　　　　　　$\phi \times f_y \times A = 0.90 \times 30,000\,psi \times 0.334\,in.^2 = 9,020\,lb$

7/8 in. bolt:　　　　　　$\phi \times f_y \times A = 0.90 \times 30,000\,psi \times 0.462\,in.^2 = 12,470\,lb$

The restraining force is equal to bolt strength × number of bolts. In case the restraining force exceeds the uplift force, the bolt can withstand the hydrostatic forces tending to cause flotation of the tanks.

The calculations of the restraining force at tank supports are given in Table 8 for the tanks in the PEWE and LET&D systems. These results demonstrate that all tanks contained in cells are adequately restrained from uplift due to buoyancy.

431.02
02/26/2002
Rev. 10

ENGINEERING DESIGN FILE

EDF-_____2470
Rev. No._____0
Page 12 of 14

Table 7.Hydrostatic forces on waste storage tanks.

Tank Identifier	Uplift force on tank support (lb)	Hydrostatic pressure on tank (psi)
WL-106	33,400	11.7
WL-107	33,400	11.7
WL-163	33,300	11.7
WL-111	7900	11.7
WL-129	3020	11.7
WL-161	3020	11.7
WL-300	940	11.7
WL-307	940	11.7
WL-301	670	11.7
WL-308	670	11.7
WL-131	180	11.7
WL-134	3070	11.7
WL-108	100	11.7
WL-109	1650	11.7
WLL-195	700	2.5

431.02   **ENGINEERING DESIGN FILE**   EDF-_____2470
02/26/2002   Rev. No. _____0
Rev. 10   Page 13 of 14

Table 8.Restraining force at tank supports.

Tank Identifier	Uplift force on tank support (lb)	Restraining force at tank support (lb)	Adequate support (Yes/No)
WL-106	33,400	36,100	Yes
WL-107	33,400	36,100	Yes
WL-163	33,300	36,100	Yes
WL-111	7900	36,100	Yes
WL-129	3020	18,000	Yes
WL-161	3020	36,100	Yes
WL-300	940	18,000	Yes
WL-307	940	18,000	Yes
WL-301	670	36,100	Yes
WL-308	670	36,100	Yes
WL-131	180	15,300	Yes
WL-134	3070	49,900	Yes
WL-108	100	12,200	Yes
WL-109	1650	12,200	Yes
WLL-195	700	49,900	Yes

431.02	**ENGINEERING DESIGN FILE**	EDF-_____2470
02/26/2002		Rev. No._____0
Rev. 10		Page 14 of 14

Conclusions

A structural evaluation was used to identify the capacity, dimensions, supports and anchorage of the liquid waste tanks in the PEWE and LET&D systems, and to show that the tanks are able to withstand hydrostatic forces resulting from the postulated 100-year flood. The tanks that are exposed to water infiltration are located in the PEWE evaporator and condenser cells and the LET&D bottoms tank pit. The analysis shows that the anchor bolts are able to withstand hydrostatic forces tending to cause flotation of the tanks. Moreover, the analysis shows that the tanks have enough strength to withstand hydrostatic forces that act on the tank walls. The structural capacity of the tanks, anchors, and foundation walls ensures that the connecting piping is not overstressed. Therefore the tanks and piping will not be damaged as a result of floodwater infiltration.

RCRA tanks that are located in concrete vaults are not exposed to water infiltration because the access hatches and pipe penetrations are watertight. The hatches are always closed except when performing maintenance in the vault, and all pipe penetrations are grouted and sealed to be watertight. Water transfers from the sumps are continually monitored, and if access hatches or pipe penetrations are found to be leaking, sealant or grout is reapplied in order to maintain a watertight vault. Therefore washout of hazardous waste from these tanks will be prevented.

Recommendations

The vent line protruding from the CPP-641 tank vault is the only pathway for water infiltration into the vaults. Therefore, it is necessary that the valve (PLV-YDB-28) on the vent line be closed during a flood.

References

1. K. N. Koslow and D. H. Van Haaften, *Flood Routing Analysis for a Failure of Mackay Dam*, EGG-EP-7184, June, 1986.
2. E. F. Brater and H. W. King, *Handbook of Hydraulics*, 6th Edition, McGraw-Hill, NY, 1976.
3. P. E. Murray, *Hydrodynamic and Structural Analyses of Flood Hazards at the PEWE and LET&D Buildings During a Peak Flow in the Big Lost River*, EDF-2613, May, 2001.
4. P. E. Murray, *Hydrodynamic and Structural Analyses of Flood Hazards at CPP-659 During a Peak Flow in the Big Lost River*, EDF-1747, January, 2001.
5. IBC-2000, *International Building Code*, International Code Council, 2000.
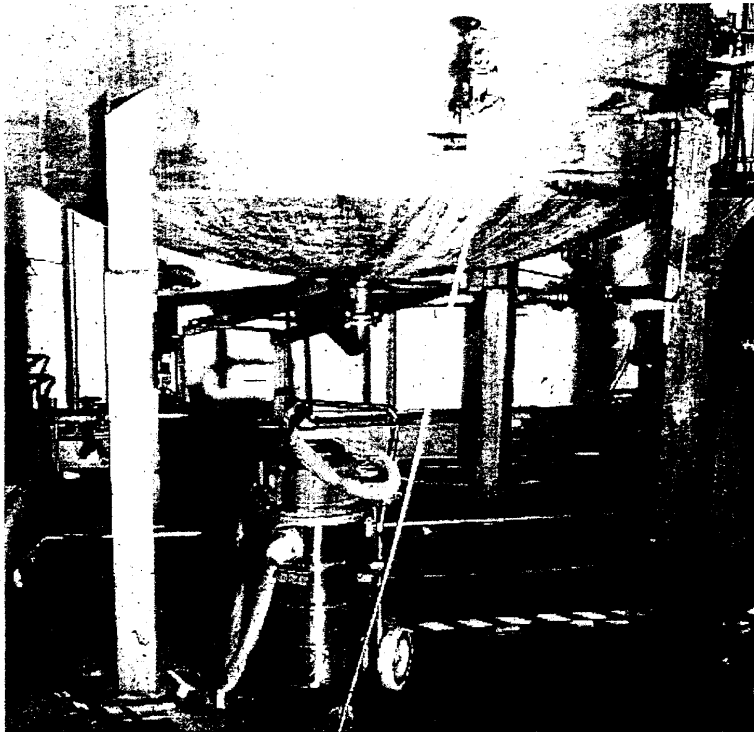
Attachments

A. Photographs of Condensate Collection Tanks.
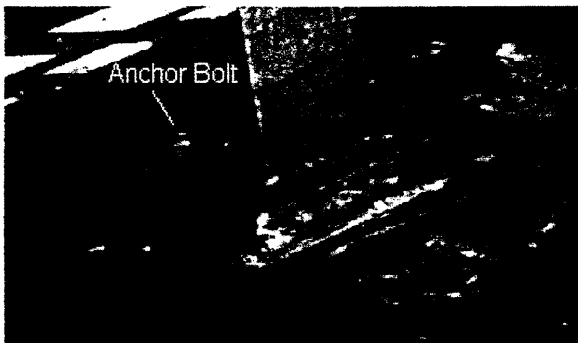
431.02
02/26/2002
Rev. 10

ENGINEERING DESIGN FILE

EDF- _____ 2470
Rev. No. _____ 0
Page A1 of A1

Attachment A – Photographs of Condensate Collection Tanks

Tank WL-106; supports for tanks WL-107 and WL-163 are similar.

Tank anchorage for WL-106; WL-107 is similar.

Tank anchorage for WL-163; four bolts are used.

RCRA PERMIT

FOR THE

IDAHO NATIONAL LABORATORY

Volume 14
INTEC Liquid Waste Management System

Appendix IX

Professional Engineer Certification of the Fuel Process
Building (CPP-601) In-cell Modifications Construction
Certification Report

Revision Date: October 29, 2008

CONSTRUCTION CERTIFICATION REPORT

FOR THE FUEL PROCESS BUILDING (CPP-601) IN-CELL MODIFICATIONS AT THE IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER, IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY,

EPA ID NUMBER ID4890008952

The Department of Energy Idaho Operations Office (DOE-ID) and Bechtel BWXT Idaho, LLC (BBWI) submitted to the State of Idaho Department of Environmental Quality (DEQ) a Hazardous Waste Management Act (HWMA)/Resource Conservation and Recovery Act (RCRA) Part B permit application for the Liquid Waste Management System at the Idaho Nuclear Technology and Engineering Center (INTEC), Idaho National Engineering and Environmental Laboratory (INEEL). The DEQ required that the INEEL certify that non-compliant discharge lines associated with the Process Equipment Waste Evaporator (PEWE) system in Building CPP-601 have been modified such that they are compliant with HWMA/RCRA requirements. This report provides the construction certification documentation for the in-cell process modifications completed by the Voluntary Consent Order (VCO) Program. These modifications address lines in C-Cell, E-Cell and L-Cell that are part of the Volume 14 RCRA Part B Permit Application.

Modifications fall under two categories: changes to the active waste transfer lines were made to ensure that units that were characterized as non-hazardous or empty process/product could not receive potentially hazardous waste discharges thus potentially changing the regulatory status of the units, and ensuring that each of the lines had adequate secondary containment to meet the RCRA requirements. A summary of the in-cell modifications is listed below.

SUMMARY OF COMPLETED MODIFICATIONS

Below is a summary of the completed modifications. Design drawings are included in Attachment A.

- The reroute of the M-Cell Sump jet line (1" PL-AR-110149) was accomplished by extending the discharge line past line 3" PL-AR-113563 in the Service Corridor to tie-in with line 3" PL-AR-151787. Line 3" PL-AR-113563 was capped where the tie-in used to be. (See Schematics P-VCOD-601-43A and -43B; Attachment A).

- The L-cell sump was rerouted to the CPP-601 PEW Collection System by installing a tee in the Service Corridor section of its existing discharge line and connecting it to the stub of the old PEW line from manifold C-103 to 3" PE-AR-151787. The previous 1½-in. drain line (1½" PE-AR-151820) from C-103 was non-compliant and therefore it was isolated by cutting and capping the line on both sides of the wall. The C-cell sump was rerouted to PEW by connecting the C-103 drain to the old line from the L-cell sump to C-101, effectively reversing its flow to the new PEW connection in the Service Corridor. The stub of the old connection to C-101 was plugged.

The PM Area sink was rerouted to PEW via a new line. The old line into C-103 (¾" TC-2091Y) from the PM Area sink was plugged at the PM Area floor. The new line uses a segment of an abandoned service waste line as a sleeve